‘‘Deposition and Characterization of Organosilicon Films Deposited by PECVD Method”

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Abstract— Polyethylene is widely used in packaging applications as it has very good mechanical and sealing properties. It is not used as single polymer due to its poor gas diffusion barrier properties. In the present work, plasma polymer coating has been deposited on polyethylene surface using Plasma Enhanced Chemical Vapour Deposition (PECVD) method. Coating experiments are being carried out using 13.56 MHz, Capacitive Coupled Radio Frequency glow discharge plasma. Base vacuum is created in the order of 10-5 mbar using Rotary – Diffusion pumping system. Films will be deposited at different RF powers. Plasma processed polyethylene surface will be characterized for surface chemistry by FT-IR spectroscopy, surface morphology by High Resolution Scanning Electron Microscopy (HR-SEM), film thickness by contact mode stylus Profilometer and for Oxygen Transmission Rate (OTR).

Key words: Plasma, Silicon oxide coating, Oxygen Transmission Rate, thickness

I. INTRODUCTION

A. Siox Film as Oxygen Diffusion Barrier Coating on Polyethylene:

- Polyethylene is a semi-crystalline polymer. Which has crystalline as well as amorphous region.
- Low density polyethylene (LDPE) is used mainly in film form for both packaging and non-packaging applications. It has good mechanical and sealing properties but very poor oxygen barrier properties. Due to this multilayer packaging structures are in use at present.
- To overcome this limitation, SiOx film is deposited which has good oxygen barrier properties and we can use homo-polymer as a packing film.
- Which can reduce the cost of packaging and it can be recycled

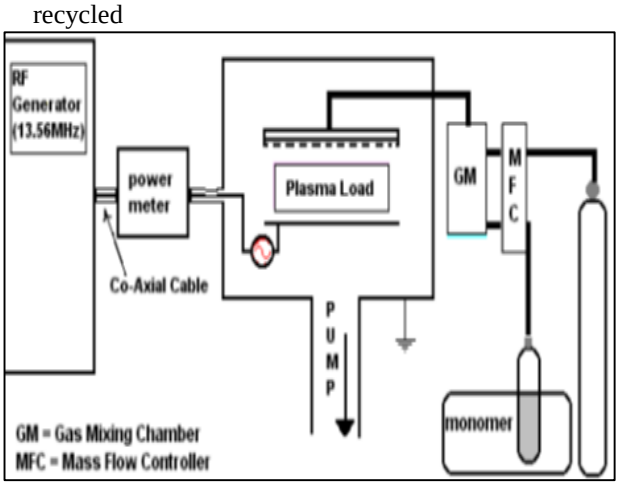

Fig. 1: Experimental setup

Fig. 2: PECVD chamber

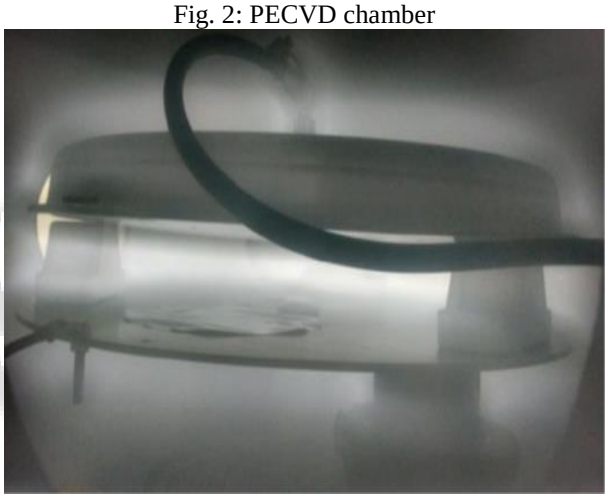

Fig. 3: Oxygen:HMDSO Plasma

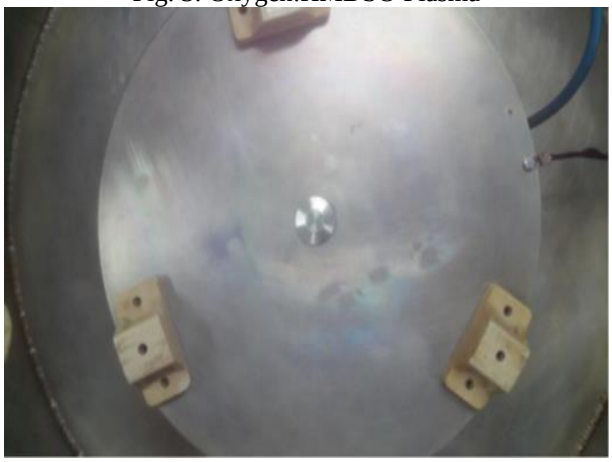

Fig. 4: Before coating electrode plate without sample

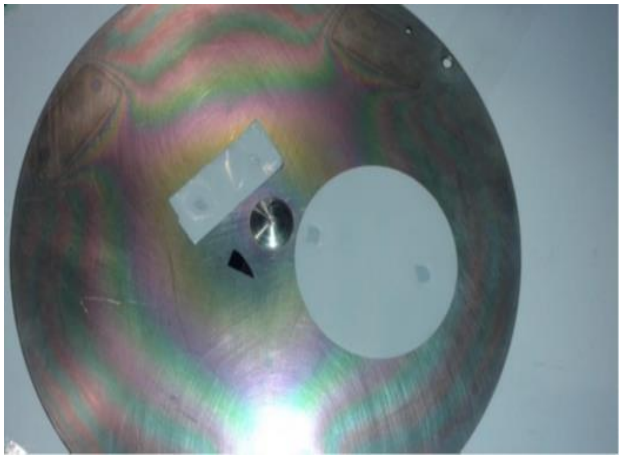

Fig. 5: After coating electrode plate with sample

II. SUMMARY OF THE WORK

This work reports the deposition and characterization of Nanometres thick SiOx film by PECVD (Plasma Enhanced Chemical Vapour Deposition) method on Polyethylene {the blend of Low Density Polyethylene (LDPE) & Linear Low density Polyethylene (LLDPE)} film substrate for the application of food packaging materials. Specially for edible Oil packaging.

- Film was deposited using Organosilicon precursor Hexamethyldisiloxane (HMDSO) and oxygen gas mixture (Oxygen: HMDSO 50:50).
- Coating experiments were conducted at 0.1 mbar operating pressure.
- Plasma was produced between two parallel plates using 13.56 MHz Radio Frequency power source.
- Deposition was carried out for 30 minutes deposition time.
- Deposited films are characterized for film chemistry by Fourier Transform Infrared (FTIR) Spectroscopy, thickness by contact based stylus Profilometer and film morphology by High Resolution Scanning Electron Microscopy(HRSEM).
- FITR results confirm the presence of Si-O-Si bonds

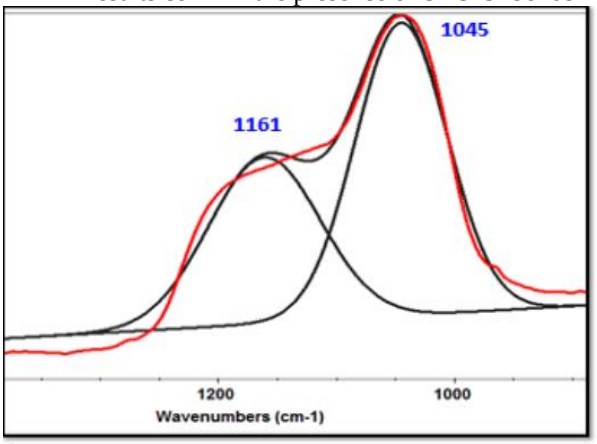

Fig. 6: FTIR Result

IR Peak (cm-1)	Chemical Bond (Mode)
1161	Si-O-Si Stretching
1045	Si-O-Si Stretching

Table 1:

III. COMPARISON OF UNTREATED AND SIOX COATED SEM IMAGES

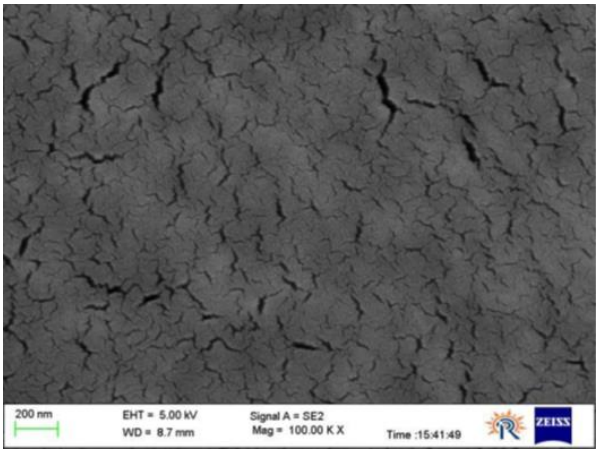

Fig. 7: Cracks on PE surface

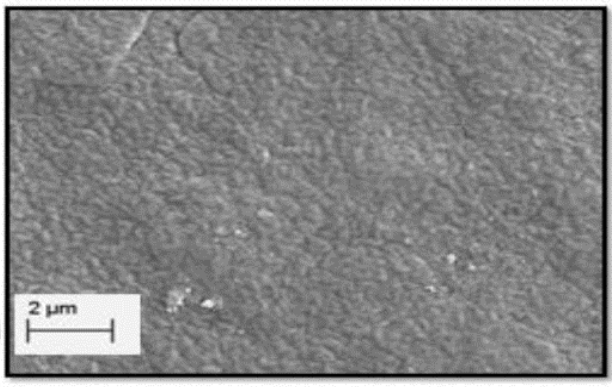

Fig. 8: Uniform coating

1) Operating pressure after plasma: 0.14 mbar
2) Power: 30W
3) OTR: 950 cc/m3/day.

IV. APPLICATION DEVELOPMENT

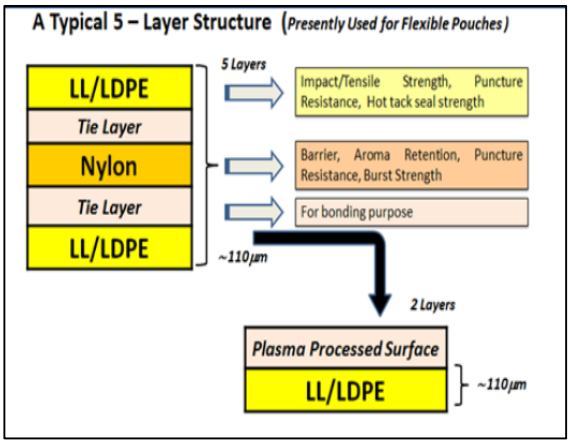

Fig. 9:

A. *Advantages:*

1) Cost effective single layer PE film for food packaging can be manufactured.
2) Properties of 5 layer barrier film can be obtained in the single layer Plasma Processed Surface.
3) Recycling is easy as compare to 5 layer barrier films.
4) In future we can replace 5 layer Polyethylene with the organosilicon coated single layer film.

"Single layer film in replacement of 5 Layer film" which can be useful in following sector: Edible Oil Packaging & others as well.

V. CONCLUSION

1) SiOx films were deposited by PECVD method.
2) FT-IR results confirm presence of Si-O-Si bonds in the film.
3) From stylus Profilometer thickness of SiOx film can be measured in nanometre range
4) From SEM image we can see that the deposited film is homogeneous.
5) OTR is obtained 950 cc/m2.day Process optimization is underway to reduce OTR value up to 150 cc/m2.day.

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